



Semantic Information Fusion

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PENNSTATE Overview – Objectives



This project addresses the severe power and processing constraints on the internetworking of mobile and fixed microsensors by devising knowledge based methods for their efficient utilization. Both Semantic and Principal Components are used to reduce data prior to transmission.

- Continuously self-configuring groups of sensor platforms are used to determine platform velocity along its track.
- Only vehicle class, peak times, and peak amplitudes are transmitted over a local area.
- Software implementation integrates with and contributes to program field

PENNSTATE Major Accomplishments



1. Develop SIF based classification software
2. Verify classification software
3. Develop velocity determination software
4. Verify velocity determination software
5. Integrate into program

PENNSTATE Improved Classification



Create a database for each class, C

Preprocessing $\{\bar{\Phi}_n\}$

Average spectral vector

$$\bar{\Psi} = \frac{1}{N} \sum_{i=1}^N \bar{\Phi}_i$$

Covariance matrix

$$\frac{1}{N} \sum_{i=1}^N (\bar{\Phi}_i - \bar{\Psi})(\bar{\Phi}_i - \bar{\Psi})^T$$

Principal components of
covariance matrix
 $\bar{\Theta}_1, \dots, \bar{\Theta}_k$

Test Databases

$$\bar{\Psi}^C, \{\bar{\Theta}_i\}^C$$

Preprocessing $\{\bar{\varphi}_n\}$

Determine error for each class

$$\varepsilon^C = \sqrt{\sum_{i=1}^r (\varepsilon_i^C)^2} \text{ where}$$

$$\bar{\varepsilon}_n^C = \bar{\varphi}_n - \bar{\Psi}^C - \sum_{k=1}^{M^C} \omega_{nk}^C \bar{\Theta}_k^C \text{ and}$$

$$\omega_{nk}^C = (\bar{\varphi}_n - \bar{\Psi}^C) \cdot \bar{\Theta}_k^C$$

Select class with lowest error



Initial Test

- This test was run after down-sampling the Sitex 02 acoustic data to 4 KHz to match our database of Sitex 00 high density data.
- The test database consisted of 20 tank peaks and 16 dragon wagon peaks.
- It included only 3 runs but had data from many microphones

Vehicles Correctly Id'ed: 30
(83%)

Correlation Coefficient: 0.69

True Tracked: 15
(75%)

True Wheeled: 15
(94%)

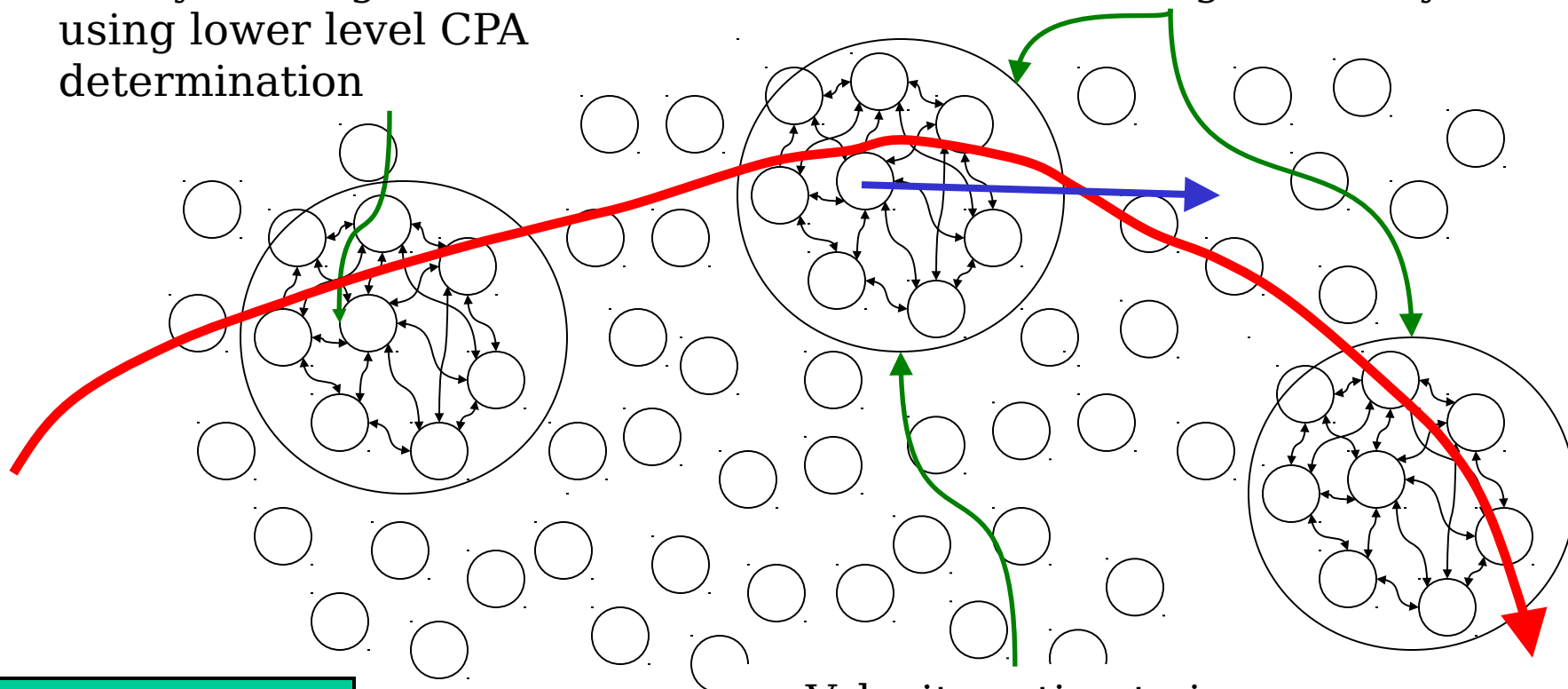
False Tracked: 1

False Wheeled: 5

Collaborative Signal Processing

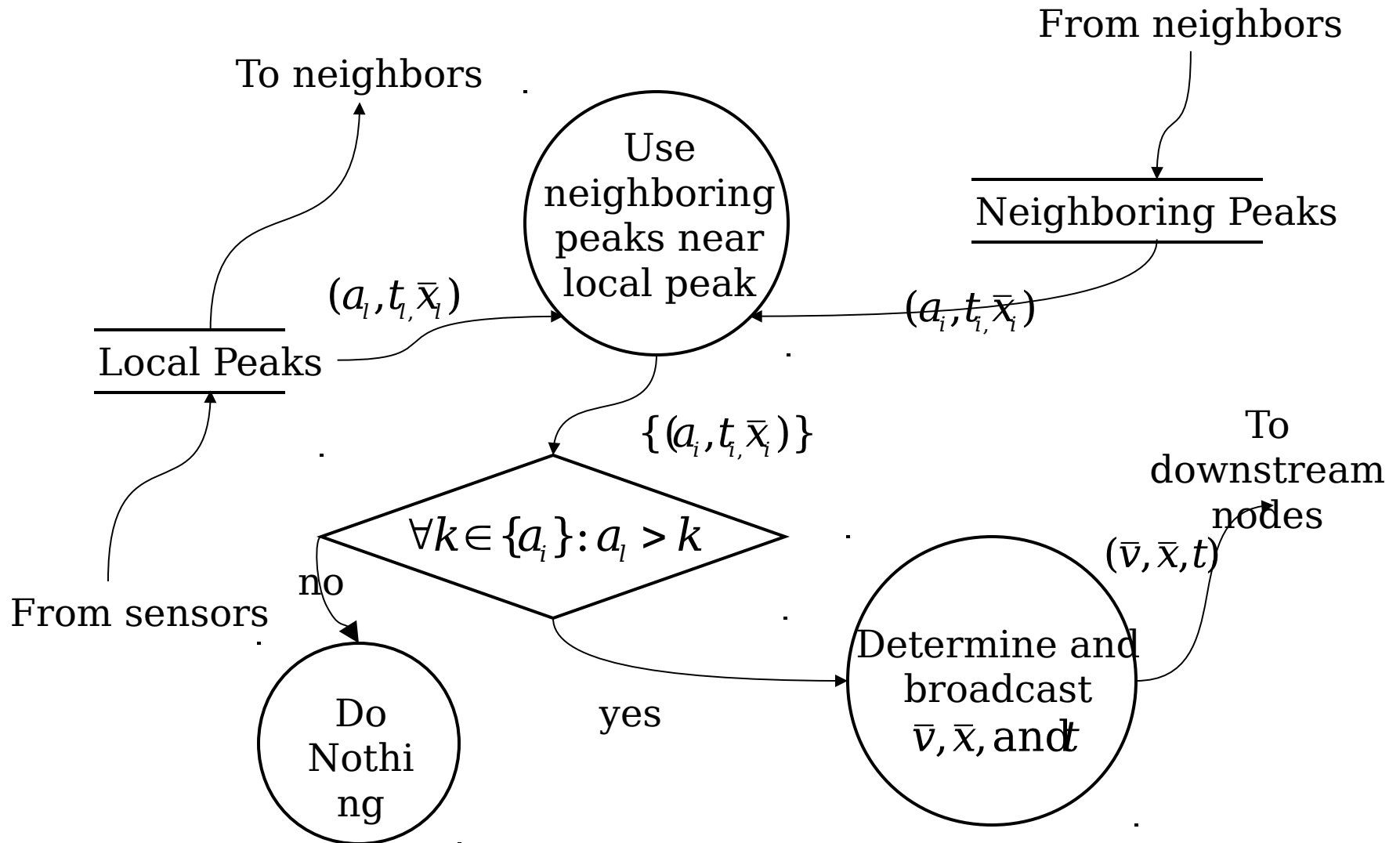
Time series are processed locally for target classification using lower level CPA determination

Nodes dynamically self-organize into groups along target trajectory to determine target velocity



Velocity estimate is broadcast along trajectory for tracking

- Target Track
- Notation
- Data Sharing
- Forward Target Track



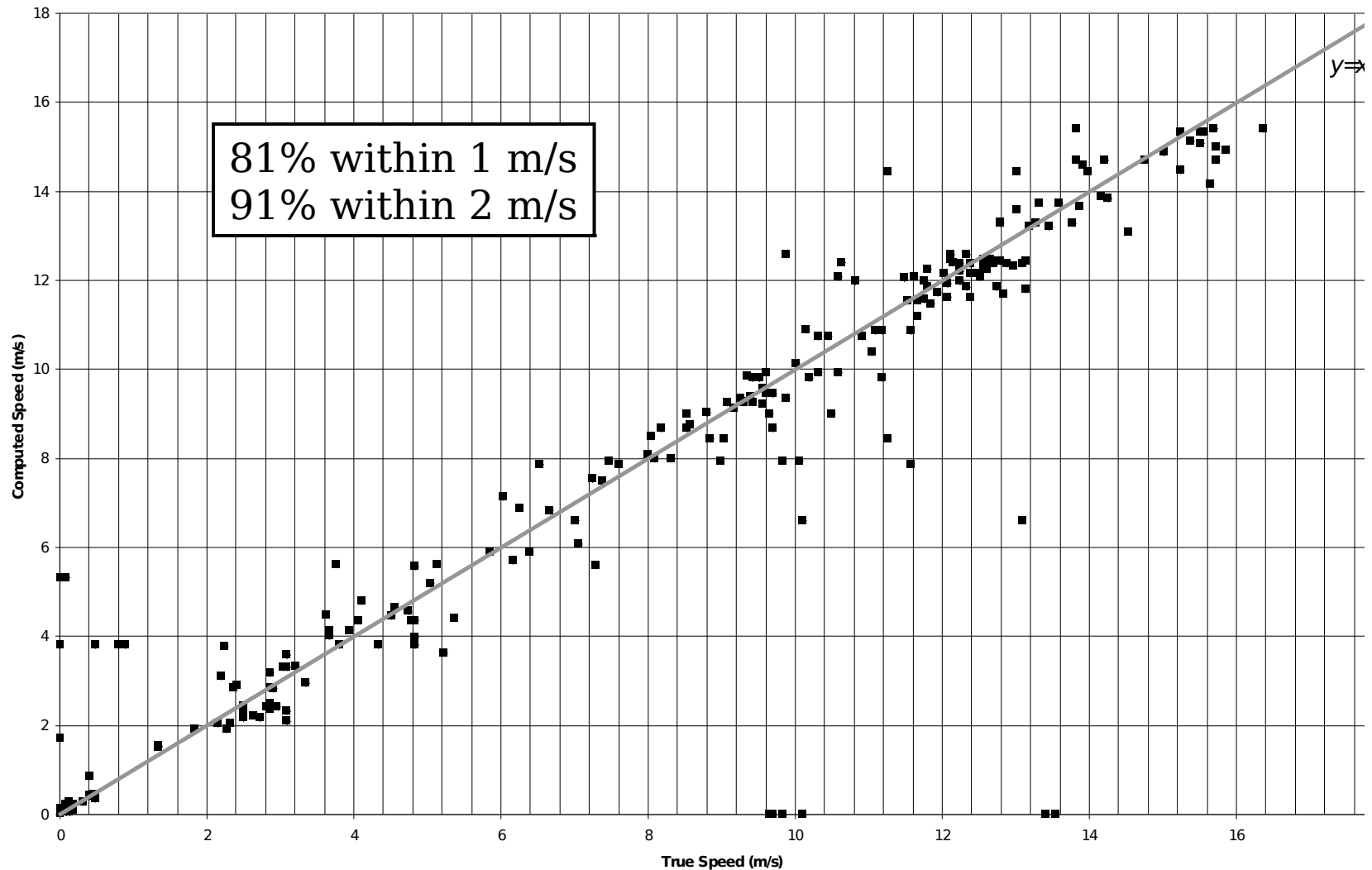


- We were not able to get valid GPS (ground truth) data for runs using the operational system, which included SIF.
- However other results (R. Brooks) imply that network latencies are not significant in a local area.
- This suggests that our previous results using Sitex '00 data and assuming no latency, are valid.

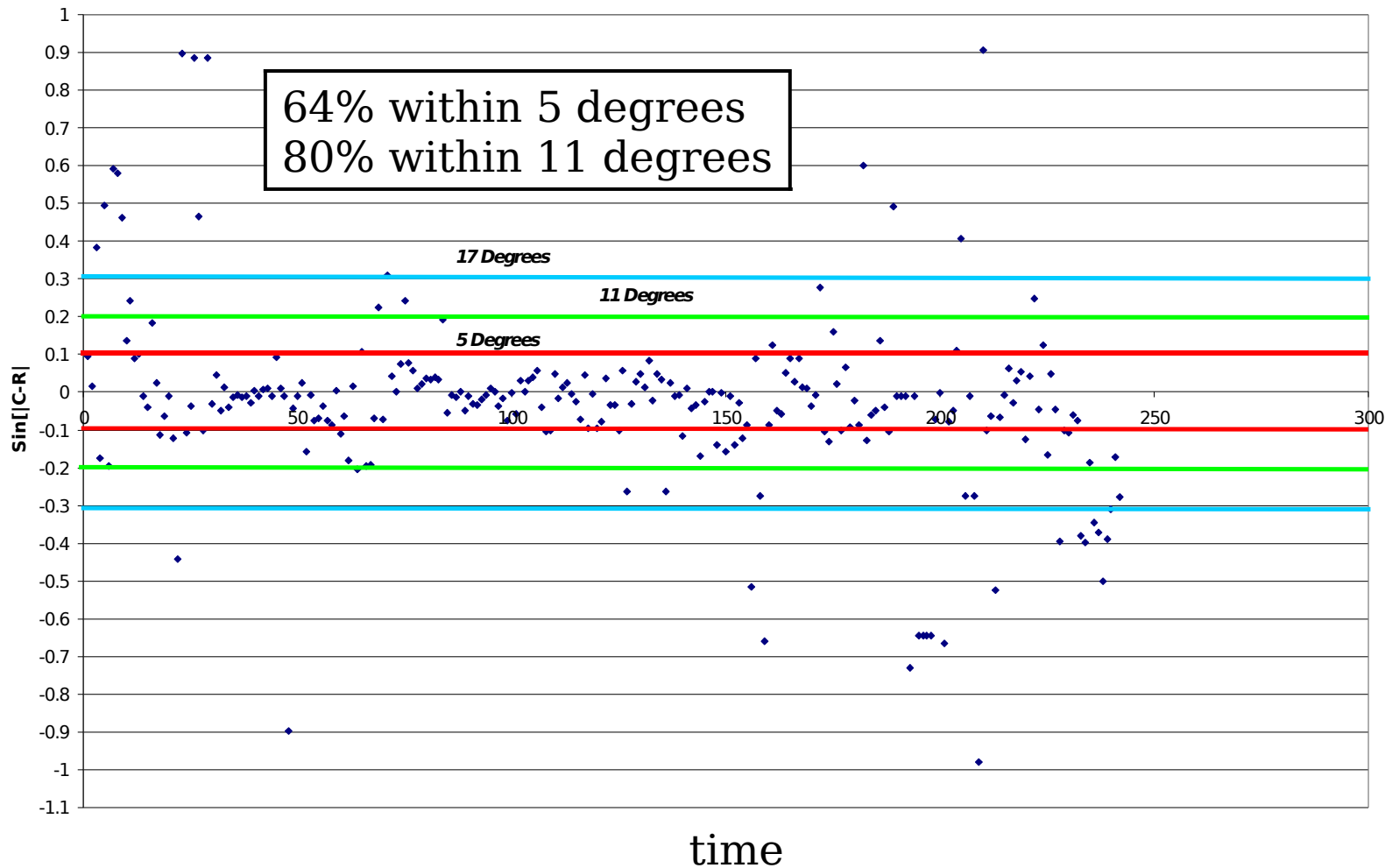
PENNSTATE Speed Results (Sitex 00)



Computed Speed vs. True Speed

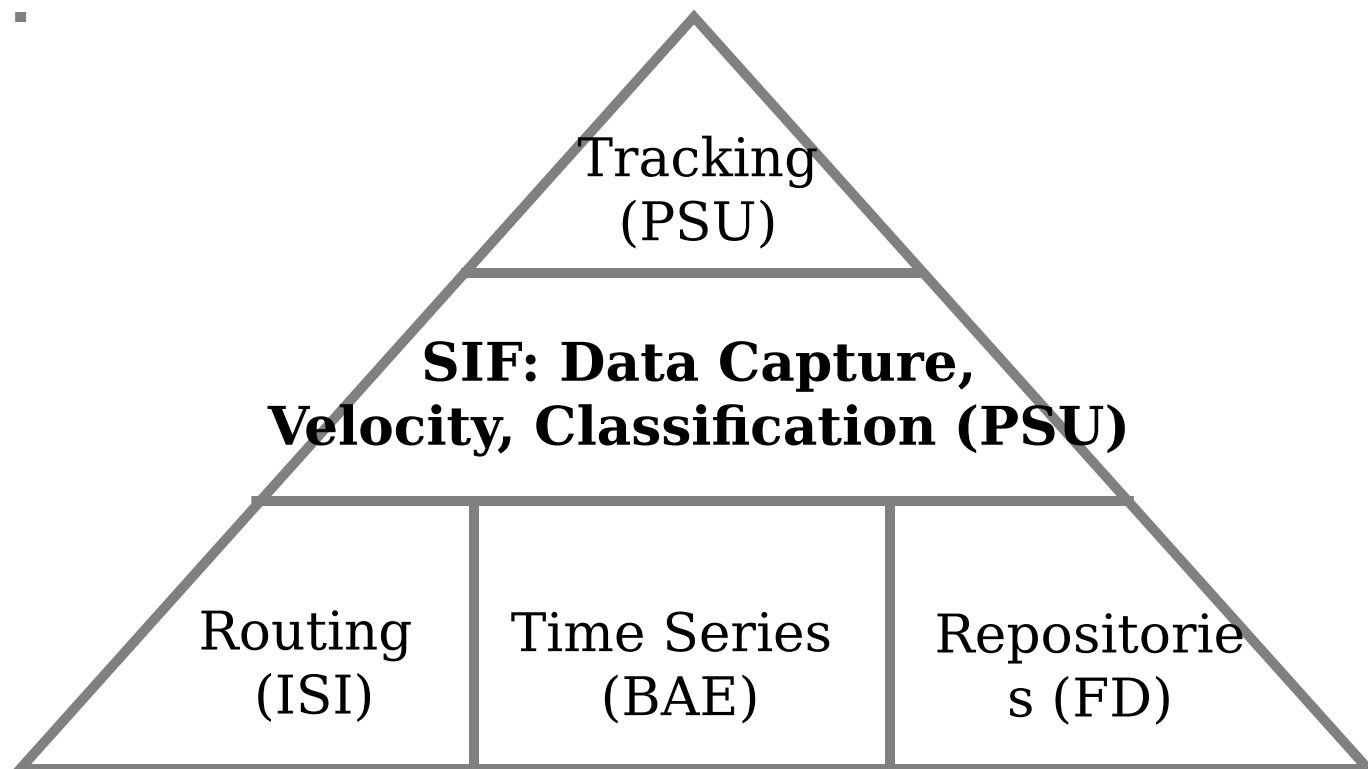


Sin of the absolute value of the Difference in Angles





How SIF fit in the Operational Demonstration





- Motivation
 - A single encapsulated common interface that eliminates the differences between multiple Data API's
- Approach
 - Develop a common, asynchronous API that present a single look and feel to the PSU SensIT Application.

Encapsulated Interfaces

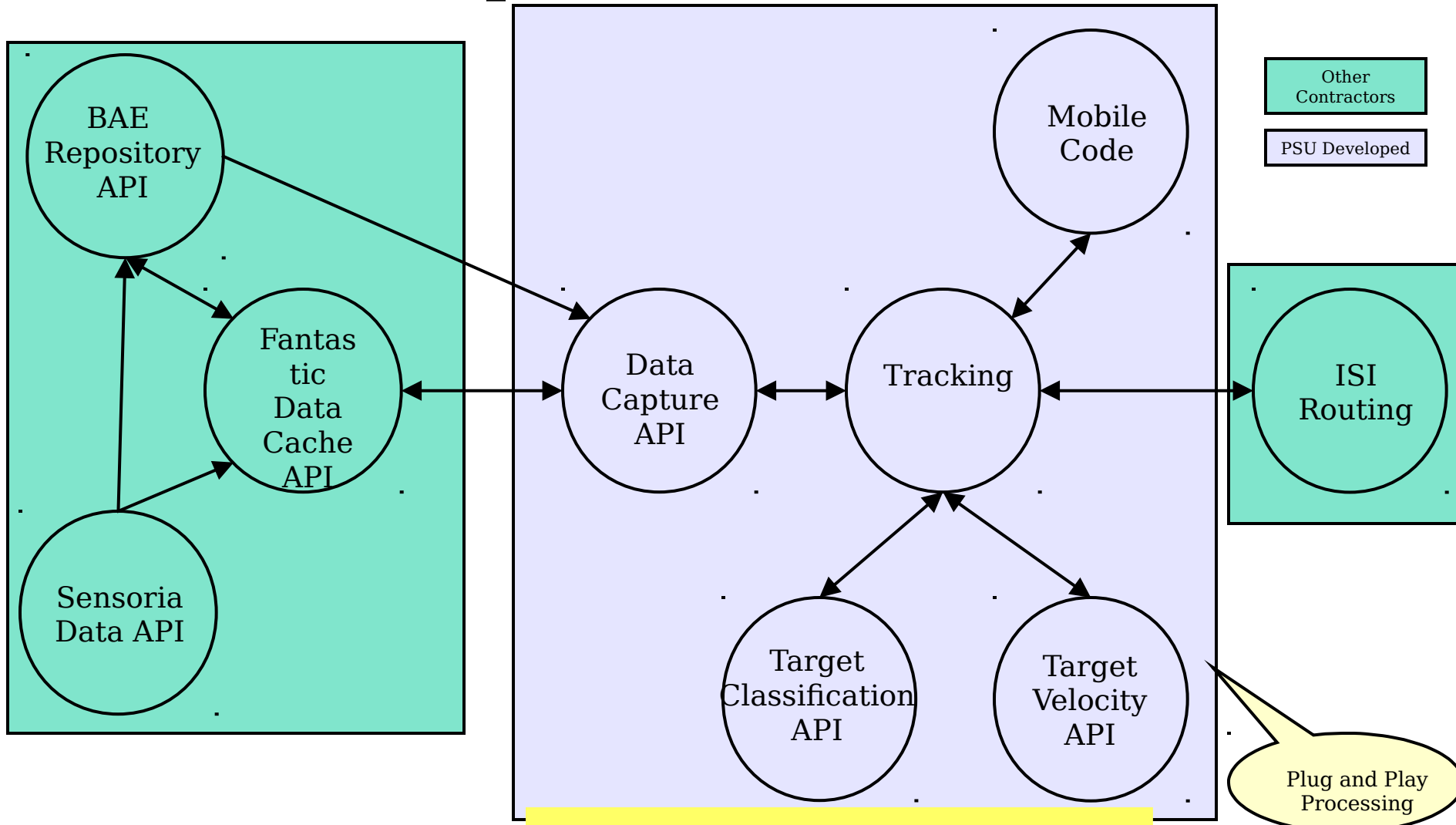


Diagram does not show interfaces between routing and low level API's



1. Verify velocity calculations
against SITEX '02 data
2. Verify classification results
against SITEX '02 data
3. Use SITEX '02 data to improve
methods
4. Participate in SITEX '03